

## **REMARKS**

In view of the above amendments and following remarks, reconsideration of the rejections contained in the Office Action of November 5, 2004 is respectfully requested.

Initially, it is noted that a number of minor editorial changes have been made to the specification and abstract for the sake of form.

Further, two additional claims have now been presented. Independent claim 15 is a new independent claim that distinguishes over the prior art of record for the same reasons as claims 1 and 2, which will be discussed below.

In response to the Examiner's request, attached is a translation of EPO 2000-186616. This translation has been obtained off of the JPO website and has not been checked for accuracy. It is noted that it is a computer translation and may contain errors.

The Examiner rejected claims 1, 2 and 4 as being clearly anticipated by EPO 2000-186616 to Akinari Ishikawa (hereinafter Ishikawa). Claims 3 and 5 were rejected as being unpatentable over Ishikawa in view of Nigro et al., U.S. Patent 6,112,715 (Nigro). Claims 6-14 were rejected as being unpatentable over Ishikawa by itself. However, it is respectfully submitted that the present invention as set forth in all of claims 1-16 clearly patentably distinguishes over each of Ishikawa and Nigro.

Increased stress conditions demanded of pistons for internal combustion engines, particularly in motor vehicles, heavy goods vehicles, agriculture machines, public works machines and ships, have rendered conventional molded or forged aluminium alloy pistons unsuitable. Thus, the present invention renders possible the manufacture of pistons for high-performance internal combustion engines by using a steel or other dense alloy with high mechanical properties instead of specially treated or shaped aluminium alloy, while providing sufficiently reduced wall thickness after forging in order to provide sufficiently low mass to obtain high performance of the engine. This is obtained by the present invention by making the piston by thixoforging.

Thixoforging is a process which shapes a metal part by forging a billet after having brought it to an intermediate temperature between its solidus temperature and its liquidus temperature, in such a way as to cause the solid matter and the liquid matter to coexist, intimately mixed, within the billet.

By comparison with conventional hot-forging processes, this makes it possible to produce parts of complex geometry which may have thin walls, and to do this using very low shaping forces. In fact, under the action of external forces the metals undergoing a thixoforging operation behave like viscous fluids. For a more particular discussion of the thixoforging of steels, please note page 4 of the original specification, beginning at line 15.

A piston 12 according to the present invention is described beginning at the next to last line of page 6 of the original specification. In a first example it is produced by thixoforging of a carbon steel. A complex geometry can result by the use of thixoforging, including obtaining a skirt 3 that is much thinner as compared with the prior art described with respect to Fig. 1. Indeed, it can be seen that in a comparison of the example of Fig. 2 and the prior art of Fig. 1, a steel piston of Fig. 2 in fact weighs less than the aluminium alloy piston of Fig. 1. The dimensional modifications that allow these differences in the thixoforged piston according to the present invention are made possible by better mechanical and thermal characteristics of the steel as demonstrated by Table 1, for example. The better mechanical characteristics of the steel allow the use of a smaller quantity of material to obtain a part with equal resistance to stresses, which makes it possible to compensate for the greater density of the steel and to obtain a part that is even lighter than its equivalent made from aluminum. Note the discussion on page 8 of the original specification.

Original method claim 1 recites the manufacture of a piston for an internal combustion engine in which shaping is carried out by thixoforging after heating of a billet to an intermediate temperature between the solidus and liquidus temperature thereof. Claim 2 recites a piston per se, made by heating the billet to the intermediate temperature and thixoforging. New independent claim 15 is an additional independent claim which recites a piston for an internal combustion engine made by the process of heating metal material so as to bring the material to an intermediate temperature between the solidus and liquidus temperature, and shaping the metal material by thixoforging the metal material at the intermediate temperature so as to form the piston.

Each of claims 1, 2 and 15 clearly distinguishes over Ishikawa and Nigro.

The Examiner takes the position that thixoforging and the thixo-cast method of Ishikawa are synonymous. However, it is respectfully submitted that they are not synonymous.

As explained above, and in the application, thixoforging is a process in which a solid billet is heated up to a temperature between the solidus and liquidus temperatures of the metal, and then forged at such temperature.

Thixocasting is a process that is used for the treatment of light alloys, but not for steel. As in thixoforging, a solid ingot is heated up to a temperature between its solidus and liquidus temperatures. But it is then transferred to a press, which is similar to presses used in molding under pressure of liquid alloys. Molding under pressure is never used for the shaping of steels. Consequently, thixocasting is not used either, because no industrial tools exist that would allow such a process to be performed on steels. The necessary temperatures would be too high. Thixocasting is used only for alloys having a relatively low fusion temperature.

Generally speaking, the solid fraction within the alloy is higher in thixoforging than in thixocasting, since during the forging step, the ingot or billet must keep a significant stiffness. On the contrary, in thixocasting it is rather advantageous to have a relatively lower solid fraction during casting in order for the metal to easily match the mold. Consequently, for a given kind of alloy, thixocasting would generally be performed at a higher temperature than thixoforging.

An additional process is described in the article "SSR integral-GTI wheels" cited by the Examiner, referred to as rheocasting. This is quite different from thixocasting and thixoforging in that it consists in casting into a mold a metal that was initially in a completely liquid state, but has been cooled down to a temperature between the liquidus and solidus, and is stirred before it is cast into the mold. So with rheocasting the starting material is a liquid, and not a solid as in thixoforging and thixocasting, by contrast.

The process described by Ishikawa is not thixoforging. Nor is it truly thixocasting as described above, but more of an injection molding process. As described in section 13 of the machine translation, a magnesium alloy and fly ash powder are mixed and supplied to an ingredient feeder 7. This is injected by high-speed injection unit 8 and a cylinder 9 and stirred by rotation of a screw 11 within the cylinder 9 while being heated at about 590°C by heater 10. It will be in a half-melting condition (thixotropy condition). It is then injected (not pressed) into metal mold 12, and cooled.

Comparing Ishikawa to claims 1 and 2, it is readily seen that Ishikawa does not heat a billet, because the material for forming the piston in Ishikawa is never in the form of a billet before heating.

It is noted that during injection molding, the temperature of the alloy must be relatively high, even if lying between liquidus and solidus, in order for the alloy to have sufficient fluidity for the molding operation. In the present invention, because it is thixoforging, as described in the specification, the liquid fraction within the billet must not be so high that it would cause collapse of the billet during heating. In the cited examples it must not be higher than 40%.

What is made clear is that the process of Ishikawa is fundamentally different from that of the present invention. It does not start out with a billet. Further, it does not shape by thixoforging, but rather by injection molding of a material in a thixotropy condition.

Thus, the Examiner's position that the process of Ishikawa is synonymous with thixoforging is traversed, and respectfully submitted to be incorrect. They are in fact distinct processes.

It is additionally noted that the Examiner has cited no evidence to support the proposition that the process of Ishikawa and thixoforging of the present invention are synonymous. As such, it is respectfully submitted that the anticipation rejection of claims 1, 2 and 4 must be withdrawn.

The Examiner further cited Nigro as teaching the provision of lugs formed by stirrup pieces 30 and ribs 33. However, the pin orifices of Nigro are in fact in the piston skirt. Nigro, further, does not cure the deficiencies of Ishikawa.

The Examiner stated, in rejecting claims 6-14, that "thixoforging is commonly used with a wide variety of elements, including those listed in the above claims." However, the Examiner has failed to cite any evidence establishing this position. As such, the rejection is traversed, and it is respectfully submitted that the rejection must be withdrawn.

The Examiner further stated that, in rejecting claims 6-14, "it would have been obvious to one having ordinary skill in the art to utilize the elements cited in claims 6-14, as these are art recognized alternatives, known for the same purpose." This is respectfully submitted to be incorrect. The Examiner's rejection proceeds on the basis of Ishikawa, which is directed to a magnesium alloy piston. However, the materials of claims 6-14 recite steel or cast iron or an alloy based on Fe-Ni or

Ni-Co. For the reasons as have been discussed above with respect to the process of Ishikawa and its applicability to the present invention, these materials would in fact not have been art recognized alternatives known for the same purpose that could be used in an operation such as disclosed by Ishikawa.

Incidentally, the piston of Nigro is not, in fact, a thick-wall piston. Thick walls in its case are necessary to resist high pressures and to remove heat from the combustion chamber, since the piston is made of an aluminum alloy. Thin walls give such a piston insufficient mechanical and thermal properties. The design of a piston according to claim 3, however, is made possible by the use of the thixoforging process and a material such as certain types of steel, cast iron and Fe-Ni. This makes it possible have simultaneously thin walls, giving the piston a low weight, and high thermal and mechanical properties, particularly at temperatures of 380°C and above, which are typical of modern high-performance engines.

As noted in the specification, while thixoforging is known per se, it has never been applied to the manufacture of pistons. Accordingly, each of independent claims 1, 2 and 15, along with their respective dependent claims, clearly recite a process that is neither disclosed nor suggested by any of the prior art cited by the Examiner. Indication of such is respectfully requested.

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance, and the Examiner is requested to pass the case to issue. If the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact Applicant's undersigned representative.

Respectfully submitted,

Marc ROBELET

By: \_\_\_\_\_



Nils E. Pedersen

Registration No. 33,145

Attorney for Applicant

NEP/krp  
Washington, D.C. 20006-1021  
Telephone (202) 721-8200  
Facsimile (202) 721-8250  
February 7, 2005